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2008

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USING DEGREE OF PROFICIENCY FOR CLASSIFYING RESPONDENTS IN IS SUCCESS EVALUATIONS

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Abstract

A contemporary Information System (IS) entails many stakeholders ranging from top executives to data entry operators, with diverse skill, expertise and knowledge. Respondent's perspective of measurement has been recognized as an important consideration in system evaluations. However, only few IS success studies report details of respondent classifications, of many are confined to the standard employment hierarchy as the sole classifier. Though the standard employment hierarchies provide reasonable insights into IS success, the results of those classifications are often subjected to respondents' emotional party-lines, thus compromising valuable management insights. Analyzing data from 310 respondents representing 27 organizations, this study proposes 'degree of proficiency' as a supplementary method of classifying respondents in IS success evaluations. The study empirically validates three types of proficiencies demonstrating their value research and practice.

Keywords: IS evaluation, multiple stakeholders, degree of proficiency

1 INTRODUCTION

Information Systems (IS) investments are under increasing scrutiny and pressure to justify their value and contribution to productivity, quality and competitiveness of the organization. Assessing the value of IS is consistently reported by organizational executives throughout the world as a key issue (Ball et al. 1982; Brancheau et al. 1987; Dickson et al. 1984). Despite the substantial investments made by organizations worldwide on IS, success of large IS, has been mixed with some studies showing positive impacts of IS in organizations (e.g. (O'Leary 2000; White et al. 1997)), while others have shown nil or detrimental impacts (e.g. (Caldas et al. 1998; Kalakota et al. 1999). Managing a contemporary IS is a complex task that. Contemporary IS entails many stakeholders ranging from top executives to data entry operators, with diverse skills, expertise, knowledge capabilities and experience. Typically, these stakeholders have multiple and often conflicting objectives and priorities and rarely agree on a set of common aims (e.g. (Cameron et al. 1983; Quinn et al. 1983; Yoon 1995).

IS research emphasizes the importance of classifying respondents into meaningful cohorts to understand respondents' unique characteristics to better manage Information Systems. Respondent's perspective of measurement has been recognized as an important consideration in system evaluations (e.g. (Cameron et al. 1983; Leidner et al. 1994; Sedera et al. 2004a; Tallon et al. 2000). However, only few IS success studies report any details of respondent classifications in their analyses, of many of which are confined to the standard employment hierarchy (e.g. executive, management and operational) as the sole respondent classifier (Sedera et al. 2006). Though the standard hierarchy provides some consolation in improving our understanding of respondent needs, these classifications are often considered too broad for identifying specific issues and problems pertaining to system usage and for practical improvement managements.

In an attempt to minimize the perplexity related to multiple employment cohorts and in attention to improve our understanding of IS evaluations, this study investigates the 'degree of proficiency' as additional method of classifying respondents. Analyzing data gathered from 310 respondents, this research-in-progress paper attempts to derive guidelines for identifying and classifying respondents into three degrees of proficiency. Once the classification guidelines are established, we seek to statistically demonstrate the validity of the new classification and explore whether the new classification provides additional management information on IS success for better IS management. Results of IS success are compared against the standard hierarchy of employment to establish possible confounding results of IS success observed in prior research. As an ancillary objective, this study explores the relationship between the years of experience and the degree of proficiency.

The paper begins with a literature review primarily aimed at deriving the classification guidelines for the degrees of proficiency. The study context is introduced next, followed by the details of the survey instrument. Subsequently, the paper outlines the classification of respondents according to the guidelines established from the literature. The data analysis is reported next providing empirical evidence of the existence of the new classification. The paper concludes with a summary of key findings.

2 DEGREE OF PROFICIENCY AND EXPERIENCE

We argue for the importance of determining the skills, expertise and knowledge of the respondent in IS success studies. While there are some direct gains in such a classification for research, there is even greater benefit to the management practice. The primary objectives of this review of literature are to; (1) establish the importance of the proposed classification method, (2) identify the salient characteristics for classifying respondents according to the degree of proficiency, and (3) identify related demographic characteristics related to this classification.

Degree of proficiency is generally associated with skills, expertise and knowledge, which extends over a continuum, from *novice → intermediate → expert*. Expertise is defined as superior

performance in terms of success, swiftness, and/or accuracy. Experts have prolonged or intense experience through practice and education in a particular field and they are able to deal with new situations in their domain. (e.g. (Ericsson et al. 1994; Glaser et al. 1988; Leplat 1986; Schvaneveld et al. 1985). Moreover, an expert has recognized knowledge and expertise who can comment authoritatively on an issue and often is asked to give an opinion with regard to the specific facts (Bainbridge 1989; Olsen et al. 1989). Experts seem to have prolonged or intense experience through practice and education on their field of expertise. In contrast, a novice has only factual and free-context rules acquired from training and is typically at the early stage of the career (Dreyfus 1992). Lying between two extremes is an intermediate. It is common practice in management discipline to employ the 'years of experience' as the sole indicator for determining the degree of proficiency. Some IS studies have employed the 'self-reporting' experts in many delphi studies (Brancheau et al. 1996; Chang et al. 2000). Though we agree that the years of experience is related and at times may influence the degree of proficiency, we question the value of such a capricious classification for contemporary IS. As described earlier, a contemporary IS involves many user cohorts from senior managers to data-entry operational employees with each cohort posses a diverse set of skills and capabilities.

In order to develop a better understating of degree of proficiency, we sought explanations from the Knowledge Management literature, where managing knowledge has been identified as a critical success factor for contemporary information system success (Bingi et al. 1999; Davenport 1996; Davenport 1998a; Davenport 1998b; Gable et al. 1998; Sumner 1999). Managing a contemporary IS , where Enterprise System (ES) is an example of, is a knowledge intensive task that necessarily draws upon the experience of a wide range of people with diverse skills and knowledge capabilities (Gable et al. 2000; Soh et al. 2000). (Demsetz 1991) and (Grant 1996) suggest that knowledge acquisition and creation requires greater specialization than is needed for utilization. Hence the production of knowledge requires the coordinated efforts of individual specialists who process many different types of knowledge. Davenport (1998b) identifies three main ES-related knowledge types: (1) software-specific knowledge, (2) business process knowledge and (3) organization-specific knowledge. (Sedera et al. 2004b) concluded that business process knowledge and organization-specific knowledge are similar and cannot be distinguished as separate entities.

Software specific knowledge refers to the knowledge, skills and expertise that those employees' posses in relation to the operation of the software they use. Business process knowledge refers to the in-depth understanding that an employees posses on not just the functional area that s/he is involved in, but the entire business process that their functional area belong to. Organizations of the 'knowledge-era' are said to be focusing on increased effectiveness through establishing strong foundations for knowledge which includes not only software knowledge but employees' knowledge of business processes and work practices. Akin to (Xu et al. 2003), we argue that most (if not all) business processes are situational in nature, where the software is adapted to meet needs of specific business circumstances. In light of those finding, we argue that the two types of knowledge of the respondents is largely responsible for the degree of proficiency.

Moreover, we explore purported relationship between the 'years of experience' and the level of expertise. Social Science research on expert performance and expertise (Chi et al. 1988; Ericsson et al. 1991) has shown that important characteristics of experts' superior performance are acquired through experience arguing that exceptional performance is an outcome of the environmental circumstances, such as the duration and structure of activities[1]. (Eriksson et al. 1993) hypothesized that the individuals' performances are a monotonic[2] function of the deliberate practice. They argued that the accumulated amount of deliberate practice and the level of performance an individual achieves at a given age is a function of the starting age for practice and the weekly amount of practice. The view that merely engaging in a sufficient amount of practice, regardless of the structure of that practice, leads to maximal performance has a long and contested history and is demonstrated in series

[1] Research demonstrates that some minimal biological attributes may also lead to the acquisition of expertise. This is considered beyond the scope of the study.
[2] Changing in one direction only; thus either strictly rising or strictly falling, but not reversing direction.

of classic studies of Morse code operators. (Bryan et al. 1897) and (Bryan et al. 1899) identified plateaus in skill acquisition, when for long periods subjects seemed unable to attain further improvements. However, they observed, with extended efforts, operators could restructure their skill to overcome plateaus. (Keller 1958) later showed that these plateaus in Morse code reception were not an inevitable characteristic of skill acquisition, but could be avoided by different and better training methods.

Given that all organizations endeavour to move their information system users to the 'expert' end of the continuum to maximize efficiency and effectiveness, usually there is a mixture of expertise, varying from novice to expert, resulting from different rates of learning, attrition, new hires, and experience through usage. In exploring an approach to identify the degree of proficiency and its possible links with years of experience, we again looked into analogous literature in social science and psychology. (Eriksson et al. 1994) suggest the statistical term *outlier* as a useful heuristic for identifying an expert. They suggest that usually, if a person is performing at least one/two standard deviation above the mean level in the population, that individual is said to be performing at an expert level. (Elo 1986) makes similar observations in relation to Chess ratings where an expert is determined using two to three standard deviations above the mean. Similarly, a person is classified as a novice, if they perform below two standard deviations below the mean of the population.

Investigating the years of experience, researchers believe that it takes ten-years to become an expert from the time at which practice was initiated (Simon et al. 1973). Simon and Chase's (1973) "10-year rule" is supported by data from a wide range of domains: music (Sosniak 1985), mathematics (Gustin 1985), tennis (Monsaas 1985), and swimming (Kalinowski 1985).

Having established the salient characteristics and the criteria for identifying the degree of proficiency and the level of experience, the paper now focuses on the study context.

3 STUDY CONTEXT

The empirical data collection was conducted across 27 large state Government departments in Queensland, Australia that have implemented SAP in the second half of 1990s. Queensland State Government is the first public sector to implement SAP worldwide and it is also the first Australian state to implement a common financial management system state-wide. In 1995, the state Government of Queensland commenced implementation of SAP Financials across all state Government agencies (later followed by Controlling, Materials Management and in some agencies Human Resources). The Queensland Government approach was very much focused on using the Enterprise System as a common reporting and financial management tool (Queensland Treasury 2000a; Queensland Treasury 2000b). The objectives of the new SAP system was to provide an IS that would: (1) support the 'Managing for Outcomes' (MFO) framework and financial management improvement activities, (2) encourage best practice resource management across the Government departments, (3) facilitate consolidation of financial information across the departments, (4) meet the business needs of departments and (5) achieve economies of scale in main operations. The sample organizations provided an ideal study context, being relatively simple and homogenous – all being departments of the same State Government; all having implemented the same ES (SAP Financials); at around the same time; and all as at data collection having been operational for approximately 5 years; thus all were at a similar point in the ES lifecycle.

4 THE SURVEY INSTRUMENT

A survey instrument[3] comprised of three sections: (1) evaluation of system success, (2) demographic data to classify the respondents according to the degree of proficiency, and (3) criterion items to make

[3] The full survey instrument is available upon request.

broader observations. In order to gather data on system success, the first part of the instrument included 27 measures as per the Enterprise Systems success Measurement Model (Gable et al. 2003; Sedera et al. 2004a). All items were scored on a seven-point Likert scale with the end values (1) 'Strongly disagree' and (7) 'Strongly Agree', and the middle value (4) 'Neutral' (see items in table 1).

In order to classify the respondents the survey gathered demographic details on respondents' employment title (e.g. Director, Business Analyst, ABAP developer). Furthermore, the respondents were asked to provide a brief description of their involvement with the SAP system. Following the findings of the literature, in order to determine the *degree of proficiency*, we employed two items to understand their software specific knowledge and the business process knowledge based on the Davenport (1998). Supplementary information on the organizational structure, characteristics of the SAP system and the number of users was also gathered from more objective sources.

Part three of the instrument included two criterion items aimed at gauging the respondent's perception of overall ES success: (1) 'overall…the impact of SAP on the agency has been positive' and (2) 'overall… the impact of SAP on me has been positive'.

System Quality		Information Quality			Individual Impact		Organisational Impact
SQ1	Ease of use	IQ1	Availability	II1	Learning	OI1	Organisational costs
SQ2	Ease of learning	IQ2	Usability	II2	Awareness / Recall	OI2	Staff requirements
SQ3	User requirements	IQ3	Understandability	II3	Decision effectiveness	OI3	Cost reduction
SQ4	System features	IQ4	Relevance	II4	Individual productivity	OI4	Overall productivity
SQ5	System accuracy	IQ5	Format			OI5	Improved outcomes/outputs
SQ6	Flexibility	IQ6	Conciseness			OI6	Increased capacity
SQ7	Sophistication					OI7	e-government
SQ8	Integration					OI8	Business Process Change
SQ9	Customisation						

Table 1: The measures of the ES-success Model

5 RESPONDENT CLASSIFICATION

The survey received a total of 319 responses representing the 27 organizations. Nine responses were removed from the data analysis due to perceived frivolity. The following section outlines how the remaining 310 respondents were categorized into the two classifications described above.

Based on their employment title and the survey information provided pertaining to their involvement with the SAP system, respondents were first categorized according to the four sub-classifications of the hierarchy of employment (i.e. Strategic, Management, Operational and Technical). In order to minimize individual errors of judgment, three academics and two senior business analysts from surveyed organizations, participated in the classification of respondents. Participants individually mapped a sample of respondents into the four sub-classifications and compared results. Guidelines were designed to increase the systemisation, repeatability and the validity of the process[4]. Comparison of the individual classifications revealed an average inter-coder agreement of 80%[5] (Krippendorff 1980). The classification exercise categorised (See table 2) 11% of respondents were from the Strategic level, 39% from Management level, 35% were from the Operational levels and 15%

[4] Classification guidelines and samples are available upon request

[5] Krippendorf (1980) recommends inter-coder reliability of at least 70% and suggests that any significant discrepancies should be discussed until consensus on the mappings is reached.

represented Technical staff. All indications suggest that this distribution is representative of users of the SAP system in Queensland Government.

Sub-classification	#	%
Strategic	35	11%
Management	122	39%
Operational Staff	108	35%
Technical Staff	45	15%
Total	**310**	**100%**

Table 2: Classification of Respondents – Hierarchy of Employment

The 'degree of proficiency', was next established employing the guidelines of Ericson and Charness (1994) and Elo (1986) using inferences from outliers and standard deviations of the items described in part two of the instrument. Following guidelines, we first established the mean and the standard deviation for the entire sample for the items that measure software knowledge and business process knowledge. The mean of the sample was 4.01 and the standard deviation was 1.001. Drawing the cut-offs for the mean values for expert, novice and intermediate classifications, an expert was considered to have mean value of 6 (or above) and respondents with a mean value of 2 (or below) were considered a novice. The cut-off values were established using the two items that gauged the software specific knowledge and the business process knowledge. This classification revealed 12% of experts, 77% of intermediates and 11% of novices (see table 3).

Sub-classification	#	%
Expert	36	12%
Intermediate	240	77%
Novice	33	11%
Total	**310**	**100%**

Table 3: Classification of Respondents – Degree of Proficiency

6 THE DATA ANALYSIS

The subsequent data analysis attempts to statistically demonstrate the validity of the classification on the degree of proficiency. The credibility of the classification is assessed first, by demonstrating that the three cohorts have differentiating views of the four success ES-success dimensions and the two criterion measures. Secondly, we demonstrate that 'experts' (derived through the degree of proficiency on software and business processes) have higher mean scores for all success dimensions, than their counterparts.

6.1 Assessing differences within Degree of Proficiency

The results in table 4 are derived using paired t-test of the three sub-classifications associated with the degree of proficiency. It is noted that every pair demonstrates significant differences on ES success for all ES dimensions and the two criterion measures. The differences observed provide evidence of the validity of this classification.

	SQ			IQ			II			OI			Overall 1			Overall 2		
	t value	df	Sig (2-tailed)	t value	df	Sig (2-tailed)	t value	Df	Sig (2-tailed)	t value	df	Sig (2-tailed)	t value	df	Sig (2-tailed)	t value	df	Sig (2-tailed)
Expert **Novice**	-5.59	68	**0**	-6.37	68	**0**	-3.45	68	**0.001**	-6.44	68	**0**	-6.75	68	**0**	-6.92	68	**0**
Expert **Intermediate**	-4	272	**0**	-4.52	272	**0**	-1.44	272	0.158	-4.38	272	**0**	-4.09	272	**0**	-4.17	272	**0**
Novice **Intermediate**	-4.38	274	**0**	-4.06	274	**0**	-3.44	274	**0**	-4.12	274	**0**	-6.09	274	**0**	-5.06	274	**0**
SQ = System Quality, IQ = Information Quality, II = Individual Impact, OI = Organizational Impact																		

Table 4: T-test of Degree of Proficiency

Moreover, the differences observed in table 4 allude to the importance of categorizing respondents using the degree of proficiency. Here, we argue that to the extent to which a respondent sub-classification demonstrates significant differences with another sub-classification (e.g. experts vs. novices OR strategic vs. operational) evidences the importance of considering such sub-classifications[6]. Next, we observe the descriptive statistics of the ES-success data for the three cohorts of respondents.

6.2 Descriptive Statistics for Degree of Proficiency

Figure 1 illustrates the mean values for the Enterprise Systems success dimensions across the three sub-classifications of degree of proficiency. It is clearly evident that the mean values of all success dimensions ascend with the increasing degree of proficiency, where experts demonstrate the highest mean values and the novices with the lowest. The results below not only provide valuable insights into the impact of the degree of proficiency, but also provide further credibility of the classification method employed in this study.

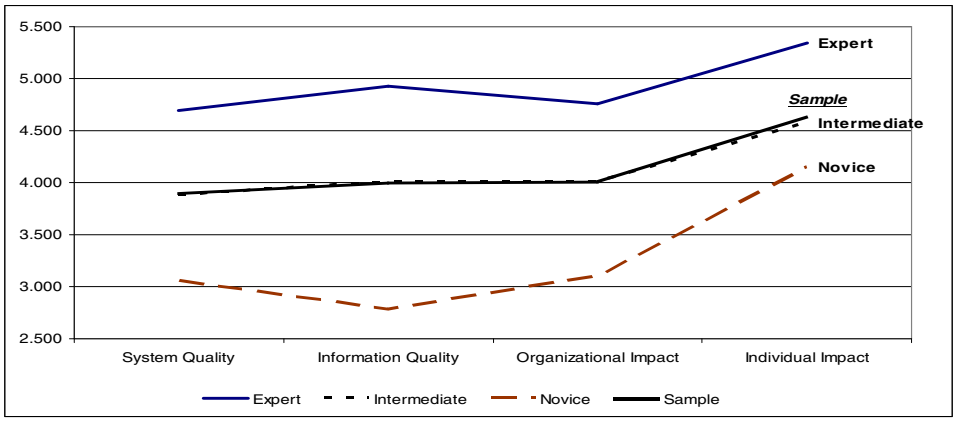

Figure 1: Descriptive Statistics for Hierarchy of Employment

6.3 Experience Required for Attainment of Expert Performance

Figure 2 demonstrates the relationship between experience and the degree of proficiency (The years of experience was gathered through part 2 of the instrument). Here, we observe a linear relationship between the degree of proficiency and the number of years with work place. This view consistent with the Ericson et al.'s (1993) suggestion of a linear relationship between 'years of experience' and the level of expertise. It is also noted that there is *no* apparent relationship between the time a respondent has served in the public sector and their level of proficiency.

[6] Similarly, if we did not observe any differences, then there is no sound basis to classify respondents in that manner for management purposes.

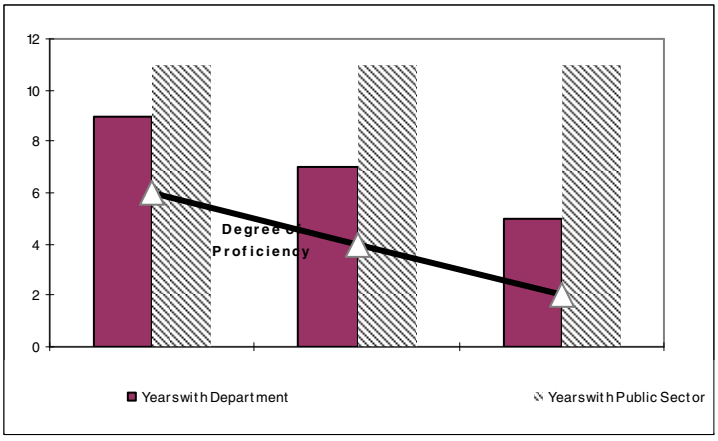

Figure 2: Experience and the Degree of Proficiency

This analysis shows that high levels of proficiency for individuals in a given domain can be attained automatically as a function of extended experience, but the level of proficiency can be increased even by highly experienced individuals as a result of deliberate efforts to improve. Hence, stable levels of performance after extended experience are not rigidly limited by unmodifiable, possibly innate, factors, but can be further increased by deliberate efforts. We have shown that expert performance is may be attained over a very long time as a result of practice and that the highest levels of performance and achievement appear to require at least around 10 years of intense prior preparation.

Moreover, cross referencing the details of the degrees of proficiencies and the standard hierarchy of employment, Table 5 investigates the relationship between the two classifications. Contrary to the popular belief that all strategic staff are perceived as experts, the analysis below shows that each hierarchy of employment includes a similar distribution of the three degrees of proficiencies. Observing individual composition of each degree of proficiency within each hierarchy of employment, it is evident that the strategic cohort has the lowest percentage of experts, where as the management cohort has the highest percentage of experts.

Cohort	Classification	#	%
	Novice	9	8.33%
Operational	Intermediate	88	81.48%
Total = 108	Expert	11	10.19%
	Novice	15	12.30%
Management	Intermediate	89	72.95%
Total = 122	Expert	18	14.75%
	Novice	3	8.57%
Strategic	Intermediate	29	82.86%
Total = 35	Expert	3	8.57%
	Novice	7	15.56%
Technical	Intermediate	34	75.56%
Total = 45	Expert	4	8.89%

Table 5: cross referencing the degrees of proficiency and hierarchy of employment

7 CONCLUSION

This paper addressed several key concerns pertaining to classifications of respondents in IS success evaluations. The respondents' 'perspective on measurement' is an important design consideration in IS evaluations, especially, when contemporary Information Systems entail many stakeholders with diverse skill, expertise and knowledge. With the intention of demonstrating the importance of individual needs of respondent cohorts and in general to better manage Information Systems, this study derived a classification to address the degree of proficiency based on: (1) software specific knowledge and (2) business process knowledge. The two dimensions of degree of proficiency are based on analogous literature in knowledge management. Though some prior IS success studies with delphi approach categorize respondents according to their 'expertise', those classifications were idiosyncratic thus lack credibility. Analyzing data from 310 respondents from 27 organizations, using the ES-success measurement survey of Gable et al., 2003, this study validated the methodology of classifying respondents into to the three degrees of proficiency.

The study also empirically demonstrated the purported relationship between the years of experience and the degree of proficiency. In agreement with Ericson, Krampe and Tesch-Romer (1993) the study found that individual degrees of proficiency has a linear relationship with the number of years that a respondent stays within an organization confirming that performance is a monotonic function of deliberate practice. However, this study did not find a relationship between the degree of proficiency and the total number of years a respondent remained in the industry sector. In testing the differences between the sub-classifications of degree of proficiency, we observed significant differences between all sub-classifications in relation to their assessment of ES success. The mean scores support arguments for finer classifications of respondents to better understand system success.

From an Enterprise Systems change management view point (including implementation, upgrades, training and process optimisation exercises), using the knowledge of the business process and the knowledge of the software allows organizations to classify respondents into three meaningful alternative classifications can be quite useful. Depending on the percentages of experts, intermediaries and the novices in each hierarchical cohort, it is conceivable to devise change management plans. Similar to views of in management science, the expert staff in each hierarchical group could act as the conduits in change management initiatives.

In conclusion, the empirical evidence demonstrated the danger of treating respondents as one dataset and the importance of classifying respondents into meaningful and logical cohorts. A meaningful classification like the degree of proficiency recognizes that the individual proficiency can be improved by providing specific software and business process knowledge through well-catered training programs.

The researchers are in progress of conducting a series of focus groups with senior Enterprise Systems management to gain further insights into the three degrees of proficiency. It is our expectation that the guidelines on business process knowledge and software specific knowledge can be further investigated. The final intention of the focus groups is to understand the management and practical implications of such classifications.

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